I. STANDARD OPERATING PROCEDURE

This document details the process and guidelines for management of intracerebral and intraventricular hemorrhage.

II. PURPOSE

Define treatment options for managing ICH/IVH. Patients with Intracerebral and Intraventricular Hemorrhage (ICH/IVH) sustain the primary insult at the initial time of bleed. Secondary damage to the brain occurs as a result of complications associated with the initial insult. These guidelines are developed to provide team members with information on managing patients after ICH/IVH and suggesting interventions to treat the associated complications.
III. DEFINITIONS

None

IV. PROCEDURE

A. Assessment

1. Clinical assessment includes:
   a. Glasgow Coma Scale. NIHSS. ICH Score. Cranial nerve exam (pupillary response, extraocular movements, facial symmetry, corneal and gag reflexes); motor strength; motor tone; sensory assessment; and vital signs. Note any seizure activity.

2. Diagnostic assessment of ICH/IVH may include:
   a. Brain imaging: CT, MRI
   b. Cerebral vascular imaging: angiogram, CTA, MRA, MRV
   c. Neuro- monitoring options:
      1) Intracranial pressure (ICP); EEG

B. Initial Management - Emergency Department or on ICU admission. Implement initial general resuscitation protocols. Appropriate interventions include:

1. Airway Management
   a. Supplemental O2 to maintain SaO2 > 92%.
   b. Intubate for respiratory distress, GCS < or equal to 8, inability to protect airway: Use RSI Protocol. Titrate ventilator to maintain PaO2 >100 mm Hg, and PaCO2 Normalized

2. Circulation
   a. Establish minimum of 2 large bore IVs
   b. Place NG/Foley if indicated.

3. Draw initial assessment labs
   a. CBC, renal profile, and cardiac enzymes; TEG profile, ASA and Clopidogrel Assay if clinically indicated.

4. Hemostasis
   a. Discontinue any anticoagulant/antiplatelet agents
   b. Reverse coagulopathy for those patients on oral anticoagulants.
   c. For those patients where it is decided not to use an anticoagulant reversal agent, must be documented in the medical record with rationale.
   d. Anticoagulation Reversal Protocol
   e. For acute warfarin related intracranial or spinal bleeding with INR > 1.4, administer one dose of vitamin K 10mg IV
   f. For acute warfarin related intracranial or spinal bleeding with INR > 1.4, administer four factor PCC (dosing determined by weight and INR level).
   g. For acute dabigatran related intracranial or spinal bleeding, administer idarucizumab.
   h. For acute intracranial or spinal bleeding related to oral Xa inhibitors (apixaban, rivaroxaban, edoxaban) administer andexanet alfa.
i. For fibrinogen < 150 give 10pk cryoprecipitate
j. For platelets < 50,000 administer two 5 pack of platelets
k. Current heparin use and PTT> 50, protamine 50mg IV x 1
l. Patients with other coagulation factor deficiency should receive appropriate factor replacement

5. Place arterial line if indicated during initial care. If patient has limited peripheral access and/or multiple infusions or blood draws requiring additional access may consider central intravenous catheter placement.

6. Diagnosis/Assessment:
   a. Obtain baseline exam including GCS and NIHSS.
   b. Document ICH Score within 6 hours of admission or prior to any surgical intervention.
   c. Perform immediate CT head without contrast.
   d. Can consider early CT angiogram to assess vasculature and for patients who may be at high risk for hematoma expansion.
   e. Arrange for other appropriate diagnostic imaging such as MRI of the brain or additional vascular imaging if indicated.

7. Hemodynamic Management:
   a. Blood Pressure Control
   b. For initial SBP between 150 and 220 mmHg and no contraindication to BP treatment, consider acute lowering of SBP to 140-160 mmHg, based on clinical judgement.
   c. For initial SBP >220 mmHg it is reasonable to consider aggressive reduction of BP with a continuous IV infusion and frequent BP monitoring.

8. Sedatives and analgesics as indicated for mechanical ventilation. Preferred agents based on desired goal:
   a. For Sedation: use propofol for mechanically ventilated patients.
   b. For Analgesia: use fentanyl

9. Management options for signs of intracranial hypertension or herniation.
   a. Hyperventilation (temporary)
   b. Mannitol
   c. Hypertonic Saline Per NSICU Protocol
   d. Consider surgical options
   e. Consider placement of ICP monitor/ventriculostomy
      1) Preferred device: ventriculostomy. If in ED, consider transfer to ICU or OR for placement.

10. Management options for signs of hydrocephalus or intraventricular hemorrhage.
    a. Keep ventriculostomy to open to drain as specified by neurosurgery
    b. Monitor intracranial pressure (ICP) every hour, goal ICP < 20 mm Hg.

C. Intensive Care Unit

1. Review all initial care needs from Section II A
   a. Place Arterial line/Central lines if clinically indicated.
b. Initiate analgesia if mechanically ventilated, monitor for effects on MAP.

2. Respiratory Management
   a. Maintain SaO2 > 92% with supplemental O2 as needed
   b. If intubated, goal PaCO2 = 35 – 45 mm Hg.

3. Neurological Examinations
   a. Nursing documentation of hourly vital signs and GCS. NIHSS documentation every 12 hours. Cranial nerve exam documented every shift.

4. Hemodynamic Management
   a. Blood Pressure Control: Target BP 140-160/90 mm Hg unless contraindications.
   b. See above protocol for treatment if outside target range.
   c. Administer fluids. Avoid hypervolemia or hypovolemia, fluid balance goal is a range of 0 – 500 ml positive every 24 hours. Goal is euvolemia.
   d. Fluid options: Normal Saline with or without 20 meg KCl, Normosol or Lactated Ringer’s solution

5. Ventriculostomy / Acute Phase ICP Management
   a. If IVH is present consider ventriculostomy placement for evidence or symptoms of hydrocephalus.
   b. Keep ventriculostomy open to drain as specified by neurosurgery
   c. Monitor ICP every hour, goal ICP < 20 mm Hg
   d. Neurosurgical resident be notified for ICP elevation
   e. Management options for signs of intracranial hypertension or herniation
      1) Hyperventilation (temporary)
      2) Mannitol
      3) Hypertonic Saline per NSICU Protocol
      4) If ventriculostomy in place ensure patency
      5) Neurosurgery consider surgical treatment options.

6. Seizure prophylaxis
   a. In patients with GCS < 8, consider continuous EEG monitoring x 72 hours.
   b. Antiepileptics may be indicated based on clinical situation including presence of clinical seizure activity or evidence on EEG.

7. DVT Prophylaxis
   a. SCD’s bilateral Lower Extremities
   b. On day 2 if hematoma stability has been documented on follow up head CT may start SQ low-molecular weight heparin or unfractionated heparin.
   c. Perform screening lower extremity ultrasounds when indicated for leg swelling or symptomatic DVT.

8. General Care Issues
   a. Glucose: Initiate treatment for hyperglycemia. Goal glucose < 180 mg/dL.
   b. Sodium: Maintain in normal range (135 – 146 mEg/L).
   c. Magnesium: Maintain > 1.8 mg/dL.
d. Temperature: Goal is normothermia. Culture per NSICU protocol for fever > 101.5°F

e. Nutrition: address within first 24 – 48 hours after admission. Keep NPO while awaiting imaging and neurosurgical plan.


g. Consult to Social Services

h. Consult other ancillary departments such as nutrition services, wound care, diabetes education, etc. as indicated.

9. Multidisciplinary Management

a. Patients admitted to the NSICU with ICH/IVH have a multidisciplinary team including neurosurgery and neurocritical care who evaluate patients before and after surgery and/or endovascular procedures.

b. Patients undergoing endovascular procedures will also be evaluated prior to and post procedure by a physician from interventional radiology.

c. Consultations to other services for pre and/or post-operative evaluation such as internal medicine, cardiology, pulmonology will be made on an as needed basis per the patient’s clinical status and past medical history.

D. Surgical Treatment / Management

1. For patients with cerebellar hemorrhage who have poor or declining neurological status due to brain stem compression and/or hydrocephalus will be evaluated for early surgical intervention

2. Open craniotomy for basal ganglia hematomas is not recommended; Minimally invasive clot evacuation can be applied in select cases based on determination of Neurosurgery Attending.

V. RESPONSIBILITY

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Responsible Staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICP insertion, ventriculostomy, hemicraniectomy, evacuation of hematoma</td>
<td>Neurosurgery</td>
</tr>
<tr>
<td>Medical &amp; Nursing Management</td>
<td>Emergency Physician and Neurocritical Care Physicians, Neurosurgery APNs, MLPs and NSICU Nursing Staff</td>
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</tbody>
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VI. KEY WORDS

Intracerebral Hemorrhage
Intraventricular Hemorrhage
Hemorrhage
Intraventricular
Intracerebral
Management of Hemorrhage
VII. APPENDIX

None

VIII. RELATED FORMS

None

IX. REFERENCES / CITATIONS